REMARKS

Reconsideration is respectfully requested.

With respect to the double patenting advice that claim 89 would be objected to under 37 CFR § 1.75 as being a substantial duplicate of Claim 77, the withdrawal of this objection in the Advisory Action dated February 26, 2004 is noted with appreciation.

Examiners Rodriguez and Davie are thanked for the courtesies and attention provided during the telephonic Examiner Interview of March 15, 2004. In accordance with the request made, attached are the arguments in written form that reflect the subject matter discussed during the Interview.

The above amendments are essentially the identical amendments that were made in the AMENDMENT UNDER 37 C.F.R. § 1.116 previously submitted on February 3, 2004. One minor additional insertion has been made in each independent claim, which was to include the term "introduction into" in the last clause, so that in the last two lines the element is recited as " he optical path of the laser signal provide a phase-conjugated feedback signal for introduction into he laser cavity for reducing power fluctuations. . ." This amendment is made only for purposes of clarification of the claim limitations, in accordance with the arguments made in the Interview

To repeat the previously made amendments, Claim 69 has been amended to incorporate the limitations of claim 71, now cancelled, claim 77 has been amended to incorporate the limitation of claim 82, now cancelled, and claim 89 has been amended to incorporate a limitation which is substantially identical to the limitations now recited in Claims 77 and 69 as added by this amendment. Claims 71 and 82 have been cancelled. It is accordingly submitted that no new matter has been added to the claims which would necessitate the conducting of a new search, on consideration, since Claims 71, 77 and 89 have been considered as Claims 71 and 82 in the prior response.

The present invention as now claimed is directed towards a method and apparatus for reducing power fluctuations in the optical output of a laser cavity. A distributed feedback laser cavity is used to generate a laser signal, and a signal portion is redirected back towards the laser cavity. A saturable absorption grating is induced in a saturable absorption element external to the laser cavity in the optical path of the laser signal as a result of wave mixing of the laser signal and the redirected signal portion. The phase-discriminating properties of the induced saturable absorption grating in the optical path of the laser signal provide a phase-conjugated feedback signal for the laser cavity for reducing the power fluctuations in optical output of the laser cavity.

In particular, as is pointed out in the specification section, Background to the Invention, the invention is directed towards the problem of reducing self-pulsations in DFB lasers which give rise to power fluctuations at the output of the laser cavity. The distributed feedback laser cavity is used to generate a laser signal, and a signal portion is redirected back towards the laser cavity. A saturable absorption grating is induced in a saturable absorption element external to the laser cavity in the optical path of the laser signal as a result of wave mixing of the laser signal and the redirected signal portion. The phase-discriminating properties of the induced saturable absorption grating in the optical path of the laser signal provide a phase-conjugated feedback signal to the laser cavity for reducing the power fluctuations in the optical output thereof. The present invention thus identifies and aims to solve in a cost effective and elegant manner the problem of self-pulsations within a laser cavity.

In contradistinction, Scifres et al. (U.S. Pat. No. 5,103,456) is directed towards high power semi-conductor diode laser configurations, and in particular towards a diode laser oscillator element which is integrated with an optical power amplifier element. As is shown in Figure 8, the diode laser master oscillator element 11 generates a coherent laser output signal, which is fed unidirectionally into a double pass amplifier section 13 via an angled coupling

grating. The double pass amplifier generates an induced gain grating which serves to stabilize the amplifier and keep it from filamentary operation. The primary function of the coupling grating 17 is to couple light undirectionally, that is from the laser oscillator to the amplifier, but not from the amplifier back into the oscillator (see column 2 at lines 24 to 27 and column 5 at lines 34 to 65). This effectively isolates or quarantines the master oscillator from any signals which could be scattered back from the amplifier 30 and the induced grating forming part of the amplifier. Scifres et al. accordingly clearly teaches against the claimed invention in that the focus of the invention is in preventing any type of signal from being fed back and interfering with the highly coherent output from the laser cavity in any way.

towards an integrated or monolithic master oscillator power amplifier (MOPA) structure Essentially the problem that Scifres et al. try to solve is related to the performance of the amplifier, and in particular the reduction of feedback from the amplifier output facet to allow the amplifier to be operated at high gain without quenching the amplifier gain, with the resultant parasitic oscillation deteriorating the spectral coherence of the amplifier (see column 1, line 64 to column 2, line 28). Scifres et al. is not at all concerned with the performance of the master oscillator and the quality of the signal it generates. According to Scifres et al., the master oscillator in fact generates a perfectly acceptable coherent output signal, and Scrifes et al. is directed towards ensuring that the coherent output signal is not deteriorated or degraded by the subsequent amplifier stage. This is achieved by ensuring unidirectional coupling by effectively isolating the amplifier from the oscillator output in the reverse direction by means of an angled grating arrangement 17 configured to provide a barrier for preventing any feedback signals from traveling towards and adversely affecting the output of the oscillator (see, for example, column 2 at lines 25 to 28, column 5 at lines 42 to 45, and column 5 at lines 49 to 65).

Nowhere in Scifres et al. are the phase discriminating properties of the induced absorbtion grating either taught or suggested, and in particular nowhere is there taught or suggested the generation of a phase-conjugated feedback signal for the laser cavity. In fact, the provision of a phase-conjugated feedback signal for the laser cavity for reducing power fluctuations in the optical output of a laser cavity is clearly taught against in Scifres et al. In brief, Scifres et al. is drawn to preserving the coherence and integrity of an acceptable coherent output signal from a laser cavity by, *inter alia*, eliminating all feedback signals which could adversely affect the output signal, and by preventing subsequent deterioration of the coherent output signal by controlling amplifier gain using a gain grating. The present invention, in contrast, is directed towards providing a phase-conjugated feedback signal for the laser cavity using an absorbtion grating with the specific purpose of reducing power fluctuations in an imperfect output signal of the laser cavity. Figs. 2 and 4 of the present invention clearly show the positive effect of phase-conjugated feedback, in particular, in eliminating sidelobes of the output signal from the laser cavity, which feature is now positively recited in each of the independent claims of this application.

Furthermore it is respectfully submitted that dependent claims 70, 72-76 and claims 78-81 and 83-88 meet the requirements of 35 USC § 102 as being dependent upon claims 69 and 71 respectively, argued above to be allowable. In addition, each of claims 70, 72-76 and claims 78-81 and 83-88 contain additional limitations, which render these claims allowable over the references cited in the outstanding rejections.

Claim 77, 78 and 81 were rejected as being unpatentable over Scifres et al. in view of Feuer (U.S. Pat. No. 6,078,597). With reference to the arguments made above in response to the claim rejections under 35 USC §102, it is further respectfully submitted that neither Scifres et al. nor Feuer disclose use of the phase discriminating properties of the induced saturable absorption

grating to provide a phase-conjugated feedback signal to the laser cavity for reducing the power fluctuations in the optical output of the laser cavity. Feuer discloses a method and apparatus for inducing a loss or gain grating in a saturable absorption medium, such as an erbium-doped fiber. Feuer teaches that noise waves of an entirely different wavelength than that of the input signal wave can be attenuated by high-absorption areas of the induced grating, as is clear from column 7 at lines 42 to 47 and the accompanying Figs. 4 and 5. Nowhere is there taught or suggested in Feuer the use of the phase discriminating properties of the induced saturable absorption grating. Rather, frequency-based discrimination is relied upon by Feuer.

Furthermore, neither suggestion nor incentive is provided in any of those cited references that would lead a person skilled in the art to arrive at the invention as claimed in independent Claims 69, 77 and 89. In view of the fact that Scifres et al. pointedly teaches away from the invention as claimed, it would not be obvious to a person having ordinary skill in the art to arrive at the claimed invention by forming the laser system of Scifres et al. into an erbium doped fiber as disclosed by Feuer. Thus, the proposed combination of references are respectfully considered to be improper are indicative of hindsight reasoning.

Even if the more counter-intuitive absorption grating combination proposed in the rejection was made, it would result in an integrated master oscillator/amplifier semi-conduction device having a laser diode oscillator, an amplifier incorporating an absorption grating wherein the frequency discriminating features of the absorption grating are relied upon, and an intervening unidirectional angled coupling grating for preventing signals from the induced grating in the amplifier from interfering with the output of the laser. The combination *per se* would clearly not achieve an obvious result over the claimed invention.

Accordingly, it would clearly not be obvious to a person having ordinary skill in the art to combine the Scifres et al. and Feuer references, and in particular the absorption grating of Feuer

et al with the high powered semi-conduction diode laser configuration of Scrifres et al. for the reason that an induced absorption grating would degrade rather than enhance the amplification performance of the amplifier and would have no influence whatsoever on the laser oscillator output. If anything in the unlikely event of the skilled person choosing to combine Feuer with Scifres et al. references, he or she would select from Feuer the gain grating rather than the absorption grating taught therein, as this combination would be less likely to adversely affect the performance of the amplifier section. Accordingly, the claimed invention is clearly non-obvious over Scifres et al. and Feuer, in whatever way combined.

For the above reasons, applicants respectfully request reconsideration and withdrawal of the outstanding rejections and earnestly solicit an indication of allowable subject matter.

Respectfully submitted,

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